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PHILOSOPHICAL TRANSACTIONS.

XIV. *An account of experiments to determine the acceleration of the Pendulum in different latitudes. By Captain EDWARD SABINE, of the Royal Regiment of Artillery, F. R. S. and F. L. S.*

Read March 8, 1821.

THE clocks and pendulums used in these experiments are the property of the Royal Society, and were prepared by their direction under the immediate superintendence of Captain KATER; who, in a manuscript account presented to the Society, of the instruments furnished to the Expeditions on Northern discovery, has described them as follows:

“ The clocks were made by SHELTON, and are the same which accompanied Captain COOK round the world: for each clock a pendulum was cast in one piece of solid brass: this was furnished with a knife edge of hard steel perfectly strait, and finished by drawing the edge longitudinally two or three times on a soft hone, so as to take from its sharpness, and thus preclude any alteration from wear; the back of the knife edge bore firmly against a stout cross piece, and the

heads of the screws securing it, were sunk below the surface, and concealed by brass pins, to prevent their being removed: the knife edge was carefully adjusted, so as to be at right angles to the direction of gravity: a very firm support of brass was screwed to the thick plank which forms the back of the clock case; in this were imbedded two pieces of agate, which were ground into portions of hollow cylinders, finished in their places to receive the knife edge of the pendulum: parallel to the agates a small level was fixed in the direction of the cylinders, by means of which they could be placed truly horizontal: an arc divided into degrees and tenths, but which might be read off by estimation to hundredths, was attached to the back of the clock case at the bottom of the pendulum, to give the arc of vibration.

“ Each clock was furnished with a triangular support of wood contrived by Dr. WOLLASTON, and so firmly arranged, that there appears no reason to apprehend any motion in the point of suspension; and it is sufficiently obvious that no change can take place in the length of the pendulum, but such as may arise from a variation in temperature. For the purpose of distinction, the two clocks and the two pendulums, are marked respectively No. 1 and No. 2.”

To this description it may be added, that the clocks were cleaned and oiled by Mr. ARNOLD, in March 1818, previous to the commencement of the experiments, and that these operations have not been needed subsequently. The oil which was used was prepared by Dr. WOLLASTON. The preparation consisted in submitting it to a low temperature, when the part which remained fluid was separated by a gentle pressure from that which had become solid; the

oil had undergone this process in the year 1803, and had been laid by since that time.

The experiments, of which the account is now presented to the Society, were made in the course of two voyages of discovery in search of a North-west passage; one in the summer of 1818, and the second in the years 1819 and 1820.

In the first of these voyages, the clock and pendulum marked No. 2, were alone employed, No. 1, being sent at the same time to Spitzbergen with Mr. G. FISHER; but both the clocks being disposable when the second expedition was fitted out, they were both embarked, with a view of obtaining double and corresponding results.

It is designed to detail, in succession, the proceedings at each station, where an opportunity was afforded of landing and setting up the clocks; and to conclude, by recapitulating the number of vibrations made by each pendulum in the different latitudes in which it was tried; and by stating the deductions regarding the figure of the earth, which follow from the accelerations which were thus determined.

FIRST VOYAGE.

Island of Brassa, Shetland.

The ships having anchored in Brassa Sound on the 30th of April 1818, for the purpose of procuring a supply of fresh provision, and their stay, although designed to be very short, being understood to depend in some measure on the wind, the clock was landed, and, by the kindness of WILLIAM MOUATT, Esq. was set up in a lower room at Gardie House,

on the Island of Brassa. It happened unfortunately, that in the interval between the 30th of April and the 3d of May, on which morning the clocks were re-embarked to proceed on the voyage, the state of the weather was such as to prevent the use of the transit instrument. The rate of the clock was therefore ascertained at this station by comparison with a chronometer, the accuracy of the result being of course dependent on the steadiness with which the chronometer maintained its accustomed rate. No. 1024 of EARNSHAW, selected on this occasion, had been received on board on the 15th of April, with an assigned rate of gaining one second daily, founded on a trial of several weeks. The longitude of Brassa is not ascertained with sufficient correctness to determine, by a knowledge of the error of the watch on mean time whilst there, the rate since the 15th; but on the 9th of June, being the first good opportunity of lunar observation which occurred subsequently, the Greenwich time obtained by the mean of several sets of distances taken by different observers, and with different instruments, agreed within four seconds of that shown by 1024, with its rate for the interval of 56 days applied. It may be also stated, as affording an inference that the rate had been particularly maintained during the early part of this interval, that a second chronometer of Mr. EARNSHAW's, No. 815, had been sent on board, also on the 15th of April, with a rate gaining 0".54 daily, determined by a similar trial to No. 1024; on the 1st of May 1024 had gained on 815 since the 15th of April 6.3 seconds, being only 6-tenths of a second less than the difference of their respective rates.

The latitude of Mr. MOUATT's house $60^{\circ} 09' 42''$ N. was

ascertained by a mean of meridian altitudes observed in November 1818, with a sextant and artificial horizon, by Captain PARRY, who on this and on all occasions most kindly studied to render me every assistance in his power, consistent with the due performance of his own duties. The house being close to the sea, the height of the clock above low water mark was ascertained by direct measurement 24 feet.

In the subjoined table is given an account of the going of the clock, as compared with No. 1024; the clock was set up on the afternoon of the 30th of April, but the account was not commenced until time had been allowed for the pendulum to acquire the temperature of the room. The temperatures and arcs of vibration are a mean of frequent observations in the times to which they correspond; and as these were of irregular duration, the corrections due to the several means have been given an influence on the general correction, proportioned to the length of their respective periods.

The correction for the arc is the number of vibrations lost by the pendulum in 24 hours, from its vibrating in a circular, instead of a cycloidal arc; the arcs being less than two degrees, the time of a vibration in a circular arc, whose radius is r : the time of a vibration in a cycloid whose axis is $\frac{1}{2}r$: $1 + \frac{a}{8r}$: 1, (a being the versed sine of the arc), and the errors arising from the greater length of the vibration in a circular arc being nearly as the square of the arc, when the number of vibrations lost by the pendulum at each station in 24 hours by vibrating in an arc of 1 degree has been ascertained, the corrections due to the arcs in which the pendulum did actually vibrate are obtained by multiplying the square of these arcs by the loss for one degree.

The correction for temperature is the reduction of the mean temperatures to 50 degrees, assumed as a convenient standard at which to compare the observations of the first voyage with each other, it being nearly the mean at which they were made; the correction has been computed from the change in the length of the pendulum due to differences of temperature, the expansion of brass being considered $+0.00220$ inches per foot in 180 degrees of FAHRENHEIT.

The correction for the height above the sea, is the part of a vibration lost in 24 hours by the pendulum in vibrating at such elevation instead of at the level of the sea, the force of gravity increasing inversely as the square of the distance from the centre of the earth. The differences of latitude being considerable between the stations at which the clocks have been set up, and the elevations being small, and differing but little from each other, it has not been deemed necessary to diminish this correction, by taking the geological character of the different stations into consideration; the character is however noted wherever it was not previously well known.

The correction for the buoyancy of the atmosphere has been computed in the manner explained by Captain KATER, in his Account of Experiments for determining the length of the Seconds Pendulum, published in the Philosophical Transactions for 1818; the specific gravity of the pendulum being considered 8.4.

Clock 2 at Brassa. Barom. Mean height 29.745 inches.

1818.	Time shown by		The Clock's gain.			Mean arc.	Mean Temp.	Corrections.				Corrected vibrations.	
	1024 gaining 1 second per diem.	The Clock.	on 1024.	on Time.	per diem.			Arc.	Temp.	Elev.	Buoy.		
	h. m. s.	h. m. s.	s.	s.	s.	o	o	s.	s.	s.	s.		
Apr. 30	18.46.10,5	18.07.10,5	} 222	223,9167	116,8488	1.8117	53	} +	5,3027	+ 2,0164	+ 0,099	+ 6,24	86530,507.
May 1	3.21.10,75	2.42.52,75				1.798	53,6						
	11.55.10,75	11.17.34				1.782	54,26						
	22.55.10,35	22.18.27				1.785	55,4						
2	9.12.10,25	8.36.16,5				1,8	56,96						
	16.45.40,25	16.10.22,25											

Being 86530,507 vibrations in a mean solar day, in *vacuo*,
at the level of the sea ; the temperature being 50°.

Hare Island.

The expedition having ascended Davis' Strait to the 70th degree of latitude, their progress in a northerly direction was interrupted on the 16th of June, by a temporary accumulation of ice. There being a possibility that the detention might be of some days continuance, the instruments were landed on the morning of the 17th, on the NE side of a small island situated on the west coast of Greenland, in latitude 70° 26', called in some charts Waygat, and in others Hare Island. Being uninhabited, and consequently affording no accommodation, a marquee was pitched for the reception of the clock ; and for its more effectual protection, the marquee was itself inclosed within a large laboratory tent, and a stove placed in

the space between the tent and the marquee for the purpose of regulating the temperature. The weather from the 17th, which was the day of landing, to the 20th, when the instruments were re-embarked, was extremely clear and fine, admitting of transit observations on the 18th, 19th, and 20th; the details of which, with the rate of the clock in the intervals, are given in the annexed Table. The latitude of the tents was ascertained by Captain PARRY, by a mean of meridian altitudes of the sun, observed with a sextant and artificial horizon, $70^{\circ} 26' 17''$ N.; the elevation above the sea was measured 44 feet; the temperatures and arcs of vibration were observed every second hour, the daily mean being inserted in the Table.

Clock 2 at Hare Island: Barom. Mean height 30.1 inches.

1818.	Observ. Times of \odot 's trans.	Mean time of App. noon.	Clock slow.	Daily gain.	Mean arc.	Mean temp.	Corrections.				Corrected vibrations.
							Arc.	Temp.	Elev.	Buoy.	
	h. m. s.	h. m. s.	m. s.				+	—	+	+	
June 18	23.48.35.58	0.00.35.06	11.59.48	153.62	1.783	43.9	5.239	2.664	0.1826	6.448	86562,8256
19	23.51.22	0.00.47.86	9.25.86	152.51	1.7825	45.6	5.236	1.925			86562,4516
20	23.54.07.31	0.01.00.66	6.53.35							Mean	86562,6386

Being 86562,6386 vibrations in a mean solar day, in *vacuo*, at the level of the sea; the temperature being 50° .

London.

No other opportunity of pursuing these experiments presented itself during the remainder of the voyage; the ships

having returned to England in the autumn of 1818, the clock was disembarked to have its rate in London ascertained. Mr. BROWNE having kindly permitted the observations for this purpose to be made at his house in Portland-place, the clock was set up in a room adjoining the one in which Captain KATER's Experiments for determining the length of the seconds pendulum had been made; the latitude, as stated by Captain KATER, being $51^{\circ} 31' 08''$,₄ N. and the height above the sea 84,5 feet. The clock was going on the 23d of December, and the account taken up on the 24th at noon, and continued through the ten following days, as shown in the annexed Table; the rate of the chronometer with which the clock was compared was supplied by Mr. BROWNE:

Clock No. 2, London; Barom. mean height 30,31 inches;
Chron. No. 112, of ARNOLD losing 0,8^c per diem.

1818.	Clock fast of 112.	Daily gain.		Mean arc.	Mean temp.	Corrections.		Daily Vibra- tions.	Corrections.		Corrected vibrations.
		on 112.	on Time.			Arc.	Temp.		Elev.	Buoy.	
	m. s.	s.	s.	o	o	s.	s.		s.	s.	
Dec. 24	0 47,3	88,7	87,9	1,66	45	4,559	2,18	86490,279			
25	02 16	88,8	88	1,69	45,8	4,703	1,838	86490,865			
26	03 44,8	88,9	88,1	1,7	44,5	4,759	2,398	86490,461			
27	05 13,7	89	88,2	1,7	45	4,759	2,18	86490,779			
28	06 42,7	89,1	88,3	1,7	45	4,759	2,18	86490,879	} +0,35	+6,457	86497,4.
29	08 11,8	88,7	87,9	1,76	44,5	5,1	2,398	86490,602			
30	09 40,5	89,4	88,6	1,82	44	5,454	2,62	86491,434			
31	11 09,9	88,5	87,7	1,82	44	5,454	2,62	86490,534			
1819. Jan. 1	12 38,4	88,5	87,7	1,83	44	5,514	2,62	86490,594			
2	14 06,9	87,6	86,8	1,835	43,5	5,544	2,84	86489,504			
3	16 34,5										

Being 86497,4 vibrations in a mean solar day, in *vacuo*, at the level of the sea; the temperature being 50° .

Results of the first Voyage.

Recapitulation.

Place of observation.	Latitude	Vibrations in a mean solar day.	Acceleration.
London	51.31.08,4N	86497,4	33,107 vibrations between London & Brassa. 32,1316 between Brassa and Hare Island. and 65,2386 between London and Hare Island
Brassa	60.09.42 N	86530,507	
Hare Island	70.26.17N	86562,6386	

SECOND VOYAGE.

It has been already noticed that both clocks were employed on the second expedition; they were placed in my charge early in 1819, to afford time for the determination of their rates in London previously to their embarkation.

The observations, of which the details are given in the subjoined Tables I. and II, were made, by Mr. BROWNE's permission, in the room already described in Portland-place; the rate of the chronometer with which the clocks were compared being supplied, as before, by Mr. BROWNE: the temperatures are corrected to 45°, being the mean to which all the observations of the second voyage are reduced;

On the return of this expedition to England in the autumn of the following year, 1820, it was judged proper to repeat these observations, for the purpose of ascertaining whether any injury producing an alteration of rate, had been sustained by either of the clocks or pendulums during the voyage; they were accordingly once more set up in Portland-place, and their going compared with Mr. BROWNE's excellent clock by CUMMING, the rate of which, losing 0,1' per diem, was furnished by Mr. BROWNE; the details are comprised in the following Tables III. and IV.

TABLE III.

Clock No. 1, in London; Barom. mean height 29,906. Cumming losing 0,1' daily.

1820.	Clock fast of Cumming.	Clock's loss.			Mean arc.	Mean temp.	Corrections.		Daily vibrations.	Corrections.		Corrected vibrations. Temp. 45°.
		on Cumming.	Per diem. on Cumming.	on Time.			Arc.	Temp.		Elev.	Buoy.	
Dec. 5	m. s. 18.02,1	s.	s.	s.	o	o	s.	s.		s.	s.	
6	17.43,1	19	19	19,1	1.38	49,14	3.132	1.811	86385,843			
7	17.24,5	18,6	18,6	18,7	1.4	50,1	3.223	2.224	86386,747			
8	17.05	19,5	19,5	19,6	1.4	50,2	3.223	2.268	86385,891			
9	16.45,	19,9	19,9	20	1.4	50,5	3.223	2.398	86385,621	+	+	
10	16.26	19,1	19,1	19,2	1.4	50,3	3.223	2.312	86386,335	3.496	6,335	86392,3353
11	16.05,8	20,2	20,2	20,3	1.41	51,1	3.27	2.664	86385,634			
15	14.49	76,8	19,2.	19,3	1.4	47,7	3.223	1.186	86385,101			

TABLE IV.

Clock No. 2 in London ; Barom. mean height 29,906 inches. Cumming losing 0,1'. daily.

1820.	Clock fast of Cumming.	Clocks Gain.			Mean Arc.	Mean temp.	Corrections.		Daily vibra- tions.	Corrections.		Corrected vi- brations. Temp. 45°.
		on Cumming.	Per diem.				Arc.	Temp.		Elev.	Buoy.	
			on Cumming.	on Time.								
Dec. 5	m. s. 8.45,2	s.	s.	s.	o	o	s.	s.	86490,337 86491,18 86490,328 86490,206 86490,85 86490,348 86489,998	+ 0,35	+ 6,3	86496,9741
6	10.07,3	82,1	82,1	82,5	1.73	52,8	4,928	3,409				
7	11.29,9	82,6	82,6	81,8	1.73	53,6	4,928	3,752				
8	12.51,8	81,9	81,9	81,7	1.73	53,25	4,928	3,6				
9	14.13,6	81,8	81,8	82,3	1.73	53,2	4,928	3,578				
10	15,36	82,4	82,4	81,5	1.73	53,3	4,928	3,622				
11	16,57,6	81,6	81,6	82,45	1.73	54	4,928	3,92				
15	22.27,8	330,2	82,55		1.73	51	4,928	2,62				

The very near agreement of the results in Tables III. and IV, with those in Tables I. and II, afforded a satisfactory proof, that no part of the apparatus had suffered by any of the accidents to which instruments are liable on a voyage of such length and peculiar circumstances, and against which the utmost precaution and care may not always be able to provide.

Rate of the clocks in London deduced from the preceding Tables.

		Vibrations in a mean solar day, Temperature 45°	
Clock	1.	{ Table I. Dec. 1818. 86392,5673 } { Table III. Dec. 1820. 86392,3353 }	86392,4513
Clock	2.	{ Table II. March 1819. 86496,997 } { Table IV. Dec. 1820. 86496,9741 }	86496,9855

Whilst the observations which have been detailed were making in 1819, it suggested itself, (at first only as a matter of curiosity), to ascertain what difference would take place in the number of vibrations made in a day by each pendulum, on its being removed into the clock numbered differently from itself. Accordingly before the instruments quitted Portland-place to be embarked, No. 1 pendulum was shifted into the clock numbered 2, and No. 2 pendulum into clock No. 1, when the following observations were made; the rate of 112 being supplied, as before, by Mr. BROWNE.

Pendulum 1 in clock 2, London; Bar. mean height 30,2 inches.
Chron. No. 112 losing 0,8". per diem.

1819.	Clock fast of 112.	Daily loss.		Mean arc.	Mean temp.	Corrections.		Daily Vibrations.	Corrections.		Corrected vibrations, Temp. 45°.
		on 112.	on Time.			Arc.	Temp.		Elevation.	Buoy.	
Jan.	m. s.	s.	s.	o	o	s.	s.			s.	
3 Mid.	6.02,5	23,5	24,3	1.74	46,25	+	+	86381,229	} + 0,3496	} + 6,43	86388,0967
4	5.39	24	24,8	1.775	47,25	5,181	0,99	86381,371			
5	5.15	24,1	24,9	1.77	47,5	5,152	1,1	86381,352			
6	4.50,9										

Pendulum 2 in clock 1, London; Bar. mean height 30,2 inches.
Chron. No. 112 losing 0,8". per diem.

1819.	Clock fast of 112.	Daily gain.		Mean arc.	Mean temp.	Corrections.		Daily Vibrations.	Corrections.		Corrected vibrations, Temp. 45°.
		on 112.	on Time.			Arc.	Temp.		Elevation.	Buoy.	
Jan.	h. m. s.	s.	s.	o	o	s.	s.		s.	s.	
3 Mid.	0.58.575	136,4	135,6	0,913	49	+	+	86538,723	} + 0,3503	} + 6,398	86545,0623
4	1.01.13,9	134,6	133,8	0,983	50	1,592	2,18	86537,572			
5	1.03.28,5	135,4	134,6	1	50,5	1,647	2,4	86538,647			
6	1.05.43,9										

Whence it appeared that the pendulum No. 1, vibrating in clock No. 2, would make 86388,0967 vibrations; and the pendulum No. 2, vibrating in clock No. 1, 86545,0623 vibrations, in a mean solar day, in *vacuo*, at the level of the sea, the temperature being 45°.

Melville Island.

Only one opportunity presented itself in the course of the second voyage of setting up the Pendulum clocks; this was during the detention of the ships at Melville Island, in the Polar Sea, in the winter of 1819—1820.

The time afforded for the observations at this station was limited by the nature of the climate alone; they were accordingly continued until the rates of the clocks were obtained with much accuracy: it has been thought proper, therefore, to give a more circumstantial detail of the proceedings at this station, than at those of the former voyage.

As soon as the harbour was determined in which it was purposed to secure the ships for the winter, and whilst a canal was cutting to admit them through the ice by which it was already occupied, its shores were carefully examined, with a view to select a suitable spot for an observatory.

The land was found of little elevation, and generally level, except where intersected by ravines, being the courses in which the winter's fall of snow drained on dissolution to the sea. The soil, which appeared by the banks of these channels to be many feet in depth, consisted of sand intermixed with small stones, being the debris of the sandstone rock of which the island is composed; it was at this time consolidated by the frost, and was harder than the original rock, but much the greater part bore evident marks of being swampy at times; and even the more elevated spots afforded little prospect of a solid foundation for the clock-stands on the return of summer.

However, as no preferable situation could be found within

such distance from the ships, as it would have been convenient, or indeed prudent, to venture, one of these was fixed on; and it was hoped that by sinking the legs of the stands a few inches into the frozen soil, and by commencing the experiments as early in the ensuing year as the season should admit, they might be completed before the ground should be affected by a thaw.

It was desirable therefore to be thoroughly prepared before the severity of the winter should set in; accordingly when the ships had been secured, and a party of men could be spared for the occasion, an observatory house was commenced. The house was built of the store plank and boards carried by the ships, care being taken to cut or injure them as little as possible; the walls were weather-boarded, lined, and filled in between with moss; the roof was protected by a tarpaulin covering: it was divided into two rooms, whereof the inner, being designed for the reception of the clocks, was warmed by pipes proceeding from a stove placed in the outer room; the floors were boarded, and the walls furnished on the inside with Russia matting. The house was finished and the clocks moved into it before the end of October.

If any hope had been entertained of being able to do more during the winter than merely to prepare for the return of more favourable weather, it was ended by the severity of cold, far exceeding expectation, with which November set in. From this date until the close of March, the highest degree registered by a thermometer, suspended in the air, was $+6^{\circ}$ of FAHRENHEIT, and in no one of these five months did the mean temperature rise above -18° ; under such circumstances, an attempt to raise the temperature of the house,

sufficiently to carry on the experiments, and to keep it up during their course, with the requisite steadiness and uniformity, must have altogether failed. It may not be amiss to remark, that notwithstanding the house was as effectual for the purpose as the utmost liberality in the supply of materials, with no labour spared in their application, could produce, a very little wind with so low a temperature abstracted the heat with such rapidity, that the influence of the stove was scarcely felt beyond its immediate vicinity; and a thermometer placed in those parts of the inner room where the clocks would have stood, could not be kept above zero, with such fire in the stove as it would have been prudent to maintain.

The clocks were therefore suffered to remain unpacked during the winter in the inner room, whilst the outer served a variety of useful purposes, which could not have been conveniently effected on board ship.

On the 24th of February, the matting with which the walls of the outer room were covered accidentally caught fire, and notwithstanding the endeavours of the persons who were present, the fire was communicated rapidly to the roof; it was at length fortunately extinguished by the exertions of the officers and men from the ships, before the clocks or any part of their apparatus had received injury; the packing chest alone of one was slightly scorched: the only personal sufferer on the occasion was an artilleryman, who had accompanied me on the voyage, and who, in his anxiety to place the instruments out of danger, exposed his hands incautiously, and was in consequence so severely frost-bitten, as to render necessary the amputation of three fingers of the left hand, and two of the right.

The house was speedily repaired, the outer room being reduced in size to a porch sufficient to contain the stove; and the inner room, which had scarcely been touched by the fire, remaining as before.

Towards the end of April the sun had influence to keep the thermometer a few degrees above zero for some hours of the day. The clocks were now unpacked and set up: the flooring being removed, the legs of the stands were placed on sleepers sunk some inches into the frozen ground in grooves which were excavated by crow bars.

It may be worthy of remark, that when the boxes containing the thermometers which accompany the clocks were opened, the mercury was observed to be retired into the bulbs and frozen, although the temperature of the air had not been so low as the freezing point of mercury for several weeks. The thermometer boxes were enclosed each with the pendulum to which it belonged, in a stout case of oak; and these again were contained in chests holding each one clock with its apparatus complete. The thermometers had been thoroughly cooled in their cases by the long continued severity of the winter; but the warmth had not yet made its way through such a multiplicity of enclosures. It may be also mentioned, in proof of the slowness with which such a mass of solid brass as constituted the bob of the pendulums conforms to the temperature of the surrounding atmosphere, compared with the mercury in the thermometer tubes, that several hours had elapsed, after the pendulums were taken out of their cases, (when it is presumed they also may have been at -40°) before they ceased to cause a deposit of moisture from the air of the room, which was about the same number

of degrees above zero : the mercury in the thermometers, on the other hand, took up the temperature of the room within half an hour after their exposure. The clocks were put in motion on the 30th of April, and the account taken up on the 4th of May, the room having been kept at about the temperature of $+45^{\circ}$ for the preceding three days and nights.

It proved however an erroneous supposition, that a sufficient interval to complete the observations would occur between the first return of mild weather, and the thorough breaking up of the frost : it was not indeed until the third week in May, that the weather became sufficiently settled or warm, to commence them to any purpose : during the first fortnight strong northerly winds prevailed with heavy snow drifts, preventing the reference to a meridian mark, and occasionally burying the house altogether beneath the drift snow ; when the only access to it was by digging down to the window of the room in which the clocks were going. It was desirable to keep the temperature of the room at about the same degree as in the experiments in London, namely, about 45° ; but the mean height of the thermometer in the air during this fortnight was not more than $+6^{\circ}$. The walls of the house had been hung round with a double folding of canvass, and were well banked up with snow on the outside ; nevertheless, it was necessary to introduce the stove into the same room with the clocks to effect so great a difference of temperature, and even to place it not far distant from them. It will readily be imagined that a forced temperature of such amount, and under such circumstances, must have been liable to incessant fluctuation and uncertainty, as indeed it was. The thermometers were suspended in the clock cases in such manner that their bulbs were on a level

with the bobs of the pendulums, and as near them as the extent of their arcs of vibration would admit: it is probable, therefore, that each thermometer was an index to the variations in temperature to which the principal part of its pendulum was subjected; but other thermometers, placed one or two feet higher in the clock cases, so far from corresponding, frequently differed many degrees from the lower one. Every gradation between the temperature of the external air and that of the stove, might be remarked at the same time by thermometers placed in different parts of the room; nor was it possible to provide against effects which changed with the situation of the sun and the direction of the wind. The thermometer was registered frequently in the hour, but the result was necessarily very unsatisfactory. Moreover, in consequence of the introduction of the stove into the room, the ground beneath the nearest legs of the stand were softened, and the levels affected, which might not have been the case could the room have been sufficiently heated by pipes.

The mean height of the thermometer in the air during the second fortnight in May was between 24° and 25° ; it is probable that the registry of the temperature of the clocks became then an approximation to the truth; but this is by no means certain, as there was yet very much inequality between the heat of the days and of the nights, the latter being still very cold; but the effects of the heat acquired by the land were now becoming manifest every where, and advancing with great rapidity.

It was soon found impracticable to keep the levels in any thing like adjustment; and by the end of the fortnight, the thaw prevailed to such an extent as to oblige the aban-

donment of the house, before any satisfactory conclusions had been obtained.

Towards the middle of June, the land was tolerably clear of snow in the neighbourhood of the harbour; the mean temperature of the air had become but little less than that at which it was desired to carry on the experiments; and the range of the thermometers in the course of the twenty-four hours had greatly diminished. An elevated and dry spot was now chosen, and the earth being removed for nearly two feet in depth (it having thawed above one foot), a foundation for the stands was made with as large stones as could be brought for the purpose, filled in with sand; the clocks were then set up, and protected by a marquee, pitched, as at Hare Island, within a laboratory tent, a stove being placed at the door of the marquee with pipes leading through the tent.

The clocks were going on the 18th of June; but a heavy gale of wind continuing through the two following days, forced the pegs and other fastenings of the tent on the weather side (it being bad holding ground), and bore it down on the marquee, until relief was sent from the Hecla, when the tent was permanently secured by ice anchors. Whilst the marquee sustained the weight of the tent, the inner walls were unavoidably pressed in several places against the clocks and stands, which were shaken thereby; one of the clocks was also stopped for the purpose of putting its pendulum in safety. This difficulty being passed, no other interruption took place to the success of the experiments. The foundation subsided a little at first, but soon became sufficiently firm and steady; a fire was generally required in the stove at night, but only occasionally during the day, the tem-

perature being very regular and satisfactory ; a thermometer suspended in the marquee on a level with the dial plates of the clocks, rarely differing more than one or two degrees at farthest from those within the cases.

In the following tables, [A. B. C.] an account is given of the going of the clocks from the 20th of June to the 14th of July, when it was conceived that a sufficient number of results had been obtained, exclusive of those before the foundation had settled, which are omitted.

The times of transit were noted by a very steady going chronometer, No. 259 of Messrs. PARKINSON and FRODSHAM. The distance being small between the tent and the observatory, the chronometer could be carried from one to the other, without inconvenience, as often as was required, by which means the comparison of intermediate watches was avoided.

The mark to which the transit instrument was adjusted previously to every observation, was about three hundred yards distant, being as far as could be distinctly seen at all times ; other marks were fixed in the prolongation of the same line at distances of one and a half, and three miles, by which the position of the first was occasionally verified.

The clocks were compared with No. 259,

1st. At every revolution of twelve hours by the chronometer, the daily rate of which was less than two seconds ; the time of comparison was, whenever No. 259 showed seven hours, or more precisely of clock 1, one minute before, and of clock 2, one minute after seven hours ; the sun's transit hav-

By Transits of the Sun, South of the Zenith ; B

		Chronometer.						Clock No. 1.															
1820		Obsd. Times of Transits.			Mean Time of Appar. Noon.			259 Fast of Mean Time.			Inter- val.	259's Gain.	Fast of 259.	Gain.			Mean Arc.	Mean Tempe- rature.	Corrections.		Vibra Solar		
		h.	m.	s.	h.	m.	s.	h.	m.	s.				days	s.	m. s.			on 259.	on Time.		per diem.	for Arc.
June 25		6.37.22,81	0.02.15,25	6.35.07,56									19.00,5										
									1	0,78				54,5	55,28	55,28	1.496	46,16	3,684	+0,51	8645		
26		6.37.36,05	0.02.27,71	6.35.08,34					4	4,64			19 55	218,2	222,84	55,71	1.497	45,59	3,689	+0,257	8645		
30		6.38.28,88	0.03.15,9	6.35.12,98					2	2,31			23.33,2	108,8	111,11	55,555	1.5	46,16	3,704	+0,51	8645		
July 2		6.38.54,13	0.03.38,84	6.35.15,29					2	3,03			25.22	108,5	111,53	55,765	1.493	45,69	3,669	+0,301	8645		
4		6.39.19,11	0.04.00,79	6.35.18,32					1	2,01			27.10,5	54,2	56,21	56,21	1.505	45,34	3,728	+0,15	8646		
5		6.39.31,63	0.04.11,3	6.35.20,33					1	1,83			28.04,7	54,4	56,23	56,23	1.533	47,09	3,868	+0,919	8646		
6		6.39.43,64	0.04.21,48	6.35.22,16					1	1,44			28.59,1	54,4	55,84	55,84	1.497	45,336	3,689	+0,148	8645		
7		6.39.54,88	0.04.31,28	6.35.23,6					1	1,26			29.53,5	54,1	55,36	55,36	1.522	47,044	3,813	+0,899	8646		
8		6.40.05,67	0.04.40,81	6.35.24,86					2	2,48			30.47,6	108,3	110,78	55,39	1.5	46,31	3,704	+0,576	8645		
10		6.40.25,95	0.04.58,61	6.35.27,34					1	1,58			32.35,9	55,3	56,88	56,88	1.43	44,57	3,366	—0,188	8646		
11		6.40.35,78	0.05.06,86	6.35.28,92					3	5,26			33.31,2	162,8	168,06	56,02	1.484	46,33	3,625	+0,585	8646		
14		6.41.02,91	0.05.28,73	6.35.34,18									36.14										

the Zenith ; Barom. mean height 29,864 inches.

Table A, to face p. 185.

. 1.			Clock No. 2.								
Corrections.		Vibrations in a mean Solar day, Temp. 45°.	Fast of 259.	Gain.			Mean Arc.	Mean Tempe- rature.	Corrections.		Vibrations in a mean solar day, Temp. 45°.
for Arc.	for Tem- perature.			on 259.	on Time.	per diem.			for Arc.	for Tem- perature.	
s.	s.		m. s.	s.	s.	s.	°	°	s.	s.	
3,684	+0,51	86459,474							+		
3,689	+0,257	86459,656	58.01,2	635,5	640,14	160,035	1.68	45,76	4,651	+0,332	86565,018
3,704	+0,51	86459,769	68.36,7	317,3	320,11	160,055	1.6735	46,37	4,615	+0,603	86565,273
3,669	+0,301	86459,735	73.54,5	317	320,03	160,015	1.662	45,94	4,552	+0,409	86564,976
3,728	+0,15	86460,088	79.11,5	158,7	160,71	160,71	1.66	45,76	4,541	+0,332	86565,583
3,868	+0,919	86461,017	81.50,2	159	160,83	160,83	1.666	47,7	4,574	+1,186	86566,59
3,689	+0,148	86459,677	84.29,2	158,8	160,24	160,24	1.672	45,81	4,607	+0,353	86565,2
3,813	+0,899	86460,072	87.08	158	159,26	159,26	1.666	47,584	4,574	+1,135	86564,969
3,704	+0,576	86459,67	89.46	317	319,48	159,74	1.672	47	4,607	+0,88	86565,227
3,366	—0,188	86460,058	95.03	159,4	160,98	160,98	1.673	45,2	4,613	+0,088	86565,681
3,625	+0,585	86460,23	97.42,4	474,6	479,86	159,953	1.674	47	4,618	+0,88	86565,451
			105.37								

86459,897, or corrected for buoyancy 86466,273.

86565,3, or corrected for buoyancy 86571,683.

86459,897, or corrected for buoyancy 86466,273.

86565,3, or corrected for buoyancy 86571,683.

By Transits of the Sun, North of the Zenith ;

1820	Chronometer.						Clock No. 1.								
	Observ. Times of Transits,	Mean Time of App. Midnight,			259 fast of mean time.	Inter- val.	259's gain.	Fast of 259.	Gain.			Mean Arc.	Mean temp.	Corrections.	
		h. m. s.	h. m. s.	h. m. s.					on 259.	on Time.	per diem.			for Arc.	for Temp.
June 25	h. m. s. 18.37.29.49	h. m. s. 12.02.21.49	h. m. s. 6.35.08	days.	s.	m. s. 19.27.4	s.	s.	s.	o	o	s.	s.		
				3	2.4		165.6	168,	56,	1,482	45.24	3,615	0.1		
28	18.38.08.57	12.02.58.17	6.35.10.4	6	8.62	22.13									
							325	333.62	55.603	1,507	45.84	3,738	0.366		
July 4	18.39.25	12.04.05.98	6.35.19.2	1	1.72	27.38									
							53.2	54.92	54.92	1,533	47.41	3,868	1.06		
5	18.39.37.08	12.04.16.34	6.35.20.74	4	6.42	28.31.2									
							217.8	224.22	56.055	1,506	46.14	3,733	0.486		
9	18.40.21.38	12.04.54.22	6.35.27.16	4	6.33	32.09									
							218.7	225.03	56.258	1.46	45.42	3,509	0.184		
13	18.40.59.18	12.05.25.29	6.35.33.49	1	2.07	35.47.7									
							52.3	54.37	54.37	1.56	51.23	4,006	2.721		
14	18.41.07.55	12.05.31.99	6.35.35.56			36.40									

By Transits of Capella, North of the Zenith ;

[illegible]

Zenith ; Barom. mean height 29,864 inches.

Table B, to face p. 185.

Clock No. 2.												
Corrections.		Vibrations in a mean solar day, Temp. 45 degrees.	Fast of 259.	Gain.			Mean Arc.	Mean Temp.	Corrections.		Vibrations in a mean solar day, Temp. 45 degrees.	
for Arc.	for Temp.			on 259.	on Time.	per diem.			for Arc.	for Temp.		
s.	s.	86459,96, or corrected for buoyancy 86466,336.	m.	s.	s.	s.	o	o	s.	s.	86565,294, or corrected for buoyancy 86571,677.	
+	+		56.41,8	477,9	480,3	160,1	1.674	45,25	4,618	0,11		
5,615	0,1		86459,715	64.39,7	951,8	960,42	160,07	1.672	46,11	4,607		0,488
7,738	0,366		86459,707	80.31,5	158	159,72	159,72	1.665	47,73	4,569		1,199
8,868	1,06		86459,848	83.09,5	634	640,42	160,105	1.67	46,72	4,596		0,755
7,733	0,486		86460,274	93.43,5	636	642,33	160,583	1,674	46,03	4,618		0,453
5,509	0,184		86459,951	104.19,5	155,5	157,57	157,57	1.681	51,77	4,657		2,956
4,006	2,721		86461,097	106.55								

Zenith ; Barom. mean height 29,864 inches.

Clock No. 2.												
Corrections.		Vibrations in a mean solar day, Temp. 45 degrees.	Fast of 259.	Gain.				Mean Arc.	Mean Temp.	Corrections.		Vibrations in a mean solar day, Temp. 45 degrees.
for Arc.	for Temp.			on 259.	on sid. time.	per diem.				for Arc.	for Temp.	
						Sidereal.	Solar.					
s.	s.		m. s.	s.	s.	s.	s.	o	o	s.	s.	
+	+		64.29							+	+	
0,472		86459,863		1106,5	1117,8	159,686	160,123	1,67	46,34	4,596	0,589	86565,308
0,789		86460,462	82.55,5	473,5	478,65	159,55	159,987	1,67	47,32	4,596	1,02	86565,603
0,506		86459,85	90.49	948,2	956,52	159,42	159,857	1,674	46,75	4,618	0,77	86565,245
			106.37,2									

86459,97, or
cor. for buoyancy
86466,346.

86565,338, or
cor. for buoyancy
86571,721.

86565,308
86565,603
86565,245

By Transits of Arcturus, South of the Zenith ; Baro

[illegible]

By Transits of α Lyrae, South of the Zenith; Barcelona

[illegible]

By Transits of α Aquilæ, South of the Zenith; Barom

[illegible]

of the Zenith ; Barom. mean height 29,864 inches.

Table C, to face p. 185.

Clock, No. 2.												
Corrections.		Vibrations in a mean solar day. Temp. 45 degrees.	Fast of 259.	Gain.				Mean arc.	Mean Temp.	Corrections.		Vibrations in a mean solar day. Temp. 45 degrees.
for Arc.	for Temp.			per diem.		for arc.	for Temp.					
s. +	s.			on 259.	on Time.			Sidereal.	Solar	s. +	s.	
3,521	—0,218	86459,737	m. s. 58.51	s. s. 318,8 320,36	160,18	160,62	1.676	44,7	s. +	4,63	—0,132	86565,118
3,763	+0,567	86459,565	64.09,8	789,7 796,52	159,304	159,738	1.678	46,49	4,64	+0,654	86565,032	
3,718	+0,193	86459,839	77.19,5	316,3 319,45	159,725	160,162	1.658	45,79	4,53	+0,345	86565,037	
3,868	+0,73	86460,551	82.35,8	158,7 160, 160,	160,438	1.67	47,244	4,596	+0,987	86566,021		
3,778	+0,802	86460,097	85.14,5	315,5 318,33	159,165	159,601	1.67	47,38	4,596	+1,047	86564,244	
3,523	+0,044	86459,899	90.30	634,5 640,11	160,062	160,5	1.68	45,77	4,651	+0,337	86565,488	
3,763	+1,399	86460,403	101.04,5	313,5 317,68	158,84	159,275	1.674	48,72	4,618	+1,635	86565,528	
			106.18									

86459,896
or corrected for the buoyancy of the atmosphere,
86466,272.

86565,268
or corrected for the buoyancy of the atmosphere,
86571,651.

of the Zenith ; Barom. mean height 29,90 inches.

3,803	+0,763	86460,319	83.05		473,5	478,8	159,6	160,037	1.67	47,26	4,596	+0,994	86565,627
3,606	—0,149	86460,403	90.58,5		159	160,19	160,19	160,63	1.67	45,283	4,596	0,126	86565,352
3,505	+0,154	86459,515	93.37,5		633,5	638,41	159,602	160,039	1.674	45,97	4,618	0,422	86565,079
4,006	+2,642	86460,89	104.11		155,7	157,59	157,59	158,022	1.681	51,56	4,657	2,864	86565,543
			106.46,7										

86460,032
or corrected for buoyancy
86466,462.

86565,344
or corrected for buoyancy,
86571,783.

of the Zenith ; Barom. mean height 29,935 inches.

3,778	+0,733	86460,501	83.12,8		473,8	479,1	159,7	160,137	1.67	47,26	4,596	+0,994	86565,727
3,64	0,088	86459,691	91.06,6		317,9	319,92	159,96	160,397	1.672	45,68	4,607	0,297	86565,301
			96.24,5										

86460,177
or corrected
86466,568

86565,555
or corrected
86571,953

ing preceded the comparison within half an hour. The rate of 259 on mean time from one noon transit to the next, and from one midnight transit to the next, being added (as the rate was always gaining) to the gain of each clock on 259 in the corresponding interval, showed the gain of the clocks respectively on mean time, as deduced from transits of the sun.

2nd. Clock 1 was compared at nine minutes, and clock 2 at eleven minutes, after a star had been observed to pass the middle wire of the transit; the gain of 259 between the transits of the star being applied, as before, to the gain of the clocks on the chronometer, their rates were obtained in the intervals of sidereal time.

The temperatures were registered every hour, and the arcs of vibration every third hour: the temperatures were occasionally noted by the serjeant of artillery, the arcs always by myself.

The results in one view of the Tables A. B. and C. are as follow;

By Transits of	Vibrations per diem.	
	Clock 1.	Clock 2.
The Sun, S. of the Zen. mean of 18 days	86466,273	86571,683
The Sun, N. of the Zen. mean of 19 days	86466,336	86571,677
Capella, N. of the Zen. mean of 16 days	86466,346	86571,721
α Lyræ, S. of the Zen. mean of 9 days	86466,462	86571,783
α Aquilæ, S. of the Zen. mean of 5 days	86466,568	86571,953
Arcturus, S. of the Zen. mean of 18 days	86466,272	86571,651

Each result being given a value proportioned to the number of days of which it is the average, the means are obtained of clock No. 1, 86466,338 vibrations, and of clock No 2, 86571,7165 vibrations per diem.

The elevation of the clocks above the sea was ascertained

by a theodolite, the telescope of which being placed on a level with the pendulums, and adjusted horizontally, the height on the ship's mast cut by the middle wire was carefully noted: this height was thirty-four feet six inches above the low water mark on a graduated tide pole, which was moored to the bottom near the ship. The measurement was repeated with the magnetic transit instrument, and gave precisely the same result. The distance between the station and the ship being about seven hundred yards, the true height may be considered thirty-four feet, the six inches being omitted in compensation of the distance. The corrections due to this elevation are for clock 1, $+0,1413$, and for clock 2, $+0,1415$, making the final results $86466,4793$ and $86571,858$ vibrations in a mean solar day, in *vacuo*, at the level of the sea; the temperature being 45° .

It has been noticed, that previous to the embarkation of the clocks on the voyage, they had gone for a few days in London with the pendulums interchanged, with a view to ascertain the comparative influence of the maintaining power of the clocks, on the number of vibrations made by each pendulum.

The preceding observations having been concluded at Melville Island on the 14th of July, at which time there appeared no immediate prospect of putting to sea as no water was yet visible, a second series was commenced with the pendulums placed in the clocks marked differently from themselves; the ships did not quit the harbour until the 1st of August, which afforded sufficient time for the completion of this series also; and thus four results were obtained, instead of two, towards the deduction of the acceleration of the pendulum at Melville Island.

1820.	Chronometer.					Pendulum 2, in Clock 1.				Barom. mean height.			
	Observ. Times of Transit.	Mean Time of App. Noon.	259 fast of mean time.	Inter- val.	259's gain.	Fast of 259.	Gain.			Mean Arc.	Mean Temp.	Corrections.	
							on 259.	on Time	per diem.			for Arc.	for Temper- ature.
July 17	h. m. s. 6.41.22,92	h. m. s. 0.05.46,17	h. m. s. 6.35.36,75	days.	s.	m. s. 10.20,3	s.	s.	s.	°	°	s. +	s.
18	6.41.29,55	0.05.50,91	6.35.38,64	1	1,89	13.49	208,7	210,59	210,59	0,92	50,025	1.396	+2,189
19	6.41.34,38	0.05.55,13	6.35.39,25	1	0,61	17.20,7	211,7	213,31	213,31	0,86	45,1	1.22	+0,04
20	—	—	—	2	1,59	20.52,9	212,2	212,99	212,99	0,894	44,97	1.318	—0,013
21	6.41.42,6	0.06.01, 6	6.35.40,84	1	1,21	24.25	212,1	212,9	212,9	0,9	44,9	1.336	—0,04
22	6.41.46,22	0.06.04,17	6.35.42,05	1	1,21	27.55,5	210,5	211,71	211,71	0,939	46,9	1.454	+0,832
23	—	—	—	2	2,2	31.26,5	211, 212,12	212,12	212,12	0,899	44,63	1.333	—0,162
24	6.41.51,64	0.06.07,34	6.35.44,3	1	1,34	34.58	211,5	212,63	212,63	0,872	44,44	1.254	—0,244
25	6.41.53,59	0.06.07,95	6.35.45,64	1	1,34	38.28,9	210,9	212,24	212,24	0,95	47,63	1.488	+1,155
26	—	—	—	3	2,92	41.58,9	210	210,97	210,97	0,91	48,21	1.366	+1,41
27	—	—	—	3	2,92	45.30,5	211,6	212,57	212,57	0,82	44,7	1.109	—0,13
28	6.41.54,96	0.06.06,4	6.35.48,56	1	2,04	49.01,3	210,8	211,78	211,78	0,88	44,	1.277	—0,44
29	6.41.55,35	0.06.04,75	6.35.50,6	1	1,98	52.31,5	210,2	212,24	212,24	0,9	45,15	1.336	+0,066
30	6.41.55	0.06.02,42	6.35.52,58	1	1,74	56.04,5	213	214,98	214,98	0,79	43,54	1.029	—0,64
31	6.41.54	0.05.59,68	6.35.54,32	1	1,74	59.35,8	211,3	213,04	213,04	0,915	44,9	1.381	—0,04

the Sun, South of the Zenith.

Table A, to face p. 186.

Barom. mean height, 29,653 inches.			Pendulum 1, in Clock 2.				Barom. mean height, 29,76 inches.				
Corrections.		Vibrations in a mean Solar day, Temp. 45°	Fast of 259.	Gain			Mean Arc.	Mean Temp.	Corrections.		Vibrations in a mean Solar day, Temp. 45°
for Arc.	for Temperature.			on 259.	on Time.	per diem.			for Arc.	for Temp.	
s.	s.		m. s.	s.	s.	s.	°	°	s.	s.	
396	+2,189	86614,175	4.52,3	47,9	49,79	49,79	1,71	49,59	4,813	+2,007	86456,61
22	+0,04	86613,57	5.40,2	50,1	50,71	50,71	1,698	44,48	4,746	—0,22	86455,236
318	—0,013	86614,295	6.30,3	50,5	51,29	51,29	1,71	13,	4,813	—0,88	86455,223
336	—0,04	86614,196	7.20,8	50,5	51,3	51,3	1,669	44,62	4,585	—0,167	86455,718
454	+0,832	86613,996	8.11,3	52,2	53,41	53,41	1,332	47.	2,92	+0,88	86457,21
333	—0,162	86613,291	9.03,5	52,5	53,62	53,62	1,56	43,86	4,006	—0,5	86457,126
254	—0,244	86613,64	9.56.	51,7	52,83	52,83	1,564	44,03	4,026	—0,422	86456,434
488	+1,155	86614,883	10.47,7								
366	+1,41	86613,746									
109	—0,13	86613,549									
277	—0,44	86612,617									
336	+0,066	86613,642									
029	—0,64	86615,368									
381	—0,04	86614,381									

86613,953, or corrected for the buoyancy of the atmosphere, 86620,293.

86456,222, or corrected for buoyancy, 86462,583.

86613,953, or corrected for the buoyancy of the atmosphere, 86620,293.

86456,222, or corrected for buoyancy, 86462,583.

By Transits of the Sun, North of th

1820.	Chronometer.					Pendulum 1, in Clock.						
	Observ. Times of Transit.	Mean Time of App. Midnight.	259 fast of Mean Time.	Inter- val.	259's Gain.	Fast of 259.	Gain.			Mean Arc.	Mean Temp.	for
							on 259.	on Time.	per diem.			
July 17	h. m. s. 18.41.27,36	h. m. s. 12.05.48,64	h. m. s. 6.35.38,72	days.	s.	m. s 5.15,7	s.	s.	s.	°	°	
24	18.41.53,44	12.06.07,72	6.35.45,75	7	7	11.10,5	354,8	361,8	51.686	1.592	45.04	+

By Transits of Stars South of the

[illegible]

By Transits of the Sun, North of the Zenith. Barom. mean height 29,76 inches.

Pendulum 1, in Clock 2.											Pendulum 2				
er- al.	259's Gain.	Fast of 259.	Gain.			Mean Arc.	Mean Temp.	Corrections.		Vibrations in a mean Solar day, Temp. 45°.	Fast of 259.	Gain.			Me Arc.
			on 259.	on Time.	per diem.			for Arc.	for Temp.			on 259.	on Time.	per diem.	
ys.	s.	m. s	s.	s.	s.	°	°	s.	s.		m. s.	s.	s.	s.	°
7	7	5.15,7	354,8	361,8	51.686	1.592	45.04	+4,172	+0,017	86455,875, or cor. for buoyancy 86462,236.	12.00,5	1482,2	1489,2	212,743	0,8
		11.10,5									36.42,7				

By Transits of Stars South of the Zenith. Barom. mean height, 29,76 Inches.

Pendulum 1, in Clock 2.										Pendulum 2				
f	Gain.				Mean Arc.	Mean Temp.	Corrections.		Vibrations in a mean Solar day, Temp. 45°.	Fast of 259.	Gain.			
	on 259.	on Time.	per diem.				for Arc.	for Temp.			on 259.	on Time.	per diem.	
			Sidereal.	Solar.									Sidereal.	Solar.
	s.	s.	s.	s.	°	°	s.	s.			m. s.	s.	s.	s.
49	50,36	50,36	50,498	1.71	47.72	+4,813	+1,186	86456,497	} 86456,249, 86462,61.	11.10,2	209,3	210,66	210,66	211,9
305,5	312,01	52,001	52,144	1.588	44,8	+4,151	—0,088	86456,207		14.39,5	1268,3	1274,81	212,47	213,9
										35.47,8	209,7	210,53	210,53	211,9
										39.17,5				
49,1	50,64	50,64	50,778	1.707	45,83	+4,796	+0,362	86455,936	} 86455,889, 86462,259.	11.47,7	210,4	211,94	211,94	212,9
304,8	310,06	51,677	51,818	1.587	44,81	+4,146	—0,083	86455,881		15.18,1	1268,1	1273,36	212,227	212,9
										36.26,2	420	422,21	211,1	211,9
										43.26,2				
48,6	50,46	50,46	50,598	1.707	45,54	+4,796	+0,235	86455,629	} 86455,898, or corrected for the buoyancy of the atmosphere, 86462,259.	11.58,2	210,5	212,36	212,36	212,9
304,8	310,43	51,738	51,88	1.587	44,81	+4,146	—0,083	86455,943		15.28,7	1267,8	1273,43	212,238	212,9
										36.36,5	420,2	422,23	211,115	211,9
										43.36,7				

Table B, *to face* p. 186.

		Pendulum 2, in Clock 1								
Vibrations in a mean Solar day, Temp. 45°.		Fast of 259.	Gain.			Mean Arc.	Mean Temp.	Corrections.		Vibrations in a mean Solar day, Temp. 45°.
			on 259.	on Time.	per diem.			for Arc.	for Temp.	
		m. s.	s.	s.	s.	o	o	s.	s.	
7	86455,875, or cor. for buoyancy 86462,236.	12.00,5 36.42,7	1482,2	1489,2	212,743	0,895	45,4	+1.321	+0,175	86614,239, or cor. for buoyancy, 86620,612.

arom. mean height, 29,76 Inches.

[illegible]

From the Tables A. and B. are derived the following results.

By Transits of	Vibrations per diem.	
	Pendulum 1, in Clock 2.	Pendulum 2, in Clock 1.
The Sun, S. of Zen.	Mean of $\left\{ \begin{array}{l} 7 \text{ days, } 86462,583 \\ 7 \quad \quad 86462,236 \\ 7 \quad \quad 86462,61 \\ 7 \quad \quad 86462,25 \\ 7 \quad \quad 86462,259 \end{array} \right.$	Mean of $\left\{ \begin{array}{l} 14 \text{ days, } 86620,293 \\ 7 \quad \quad 86620,612 \\ 8 \quad \quad 86620,672 \\ 9 \quad \quad 86620,578 \\ 9 \quad \quad 86620,625 \end{array} \right.$
The Sun, N. of Zen.		
Arcturus -		
α Lyrae -		
α Aquilæ -		

Each result being given a value proportioned to the number of days of which it is the average, the mean results are of No. 1 pendulum 86462,3876, and of No. 2 pendulum 86620,523 vibrations; by adding to these numbers the corrections due to the elevation above the sea, being +0,1413 to No. 1, and +0,1416 to No. 2, a final result is obtained; that No. 1 Pendulum vibrating in Clock No. 2 at Melville Island would make 86462,5289 vibrations, and No. 2 Pendulum in Clock No. 1, 86620,6646 vibrations, in a mean solar day, *in vacuo*, at the level of the sea, the temperature being 45°.

The latitude of the spot where the preceding observations were made was 74° 47' 12,4", deduced by a mean of 39 meridian altitudes of the sun, observed by Captain PARRY and Mr. BEECHEY, with reflecting circles and sextants with an artificial horizon; the results have been re-computed since the return of the Expedition, using the table of atmospheric refractions, published by Dr. YOUNG in the Nautical Almanack of 1822; the elements of these observations are given in the Appendix to the Narrative of the Voyage, pages lxxxviii and lxxxix.

Results of the preceding operations.

It remains to recapitulate the results which have been detailed, and to state the deductions thereupon.

The acceleration of the pendulum between the stations visited in the first voyage has been already mentioned, viz.

33,107 vibrations between London and Brassa;

32,1316 vibrations between Brassa and Hare Island;

And 65,2386 vibrations between London and Hare Island;

The following Table presents in one view, the results of the four series of observations, by which the acceleration between London and Melville Island has been determined.

		Vibrations.		Acceleration.	
		London.	Melville Island		
Clock 1,	Pendulum 1,	86392,4513	86466,4793	74.028	} 74.8151
	Pendulum 2,	86545,0623	86620,6646	75.6023	
Clock 2,	Pendulum 1,	86388,0967	86462,5289	74.4332	} 74.6529
	Pendulum 2,	86496,9855	86571,858	74,8725	

It should be remarked, that in the earliest trial which was made of the clocks, No. 2 was considered to be deserving of preference, from its greater precision of beat, occasioned probably in part by the crutch of No. 1 being rather larger than the diameter of the pendulum rods; the above results seem to justify the preference, as the acceleration produced by each of the pendulums vibrating in No. 2, corresponds better than their results when vibrating in No. 1. It will be seen, however, that a mean of the results of either clock separately,

coincides within a tenth of a vibration, with the mean result in the foregoing table.

Assuming then the length of the pendulum vibrating seconds in the latitude of London, viz. $51^{\circ} 31' 08,4''$ at 39,13929 inches, which has been determined by Captain KATER, the following Table presents its length at each of the stations at which the clocks have been set up, deduced from the observations which have been detailed.

Place of Observation.	Latitude.	Length of the pendulum vibrating seconds.
		Inches.
London	$51^{\circ} 31' 08,4''$ N.	39.13929
Brassa	60.09.42	39.16929
Hare Island	70.26.17	39.1984
Melville Island	74.47.12,4	39.207

Deductions as to the Figure of the Earth.

The following Table contains the diminution of gravity from the Pole to the Equator, and the resulting ellipticity of the earth deduced from the preceding observations.

The method which has been followed in obtaining these deductions, is the same which has been described by Captain KATER in the Philosophical Transactions for 1819, p. 420, and 421.

	Diminution of Gravity.	Ellipticity.
London and Brassa	·0055066	$\frac{1}{314,3}$
London and Hare Island	·0055082	$\frac{1}{314,2}$
Brassa and Hare Island	·0055139	$\frac{1}{313,6}$
London and Melville Island	·0055258	$\frac{1}{312,6}$

In concluding the account of these experiments, it is proper that I should notice, that their success is in great measure to be attributed to Mr. BROWNE and to Captain KATER : to Captain KATER for his care and judgment in preparing the instruments, and to Mr. BROWNE for permitting the clocks to be set up in his house in London, and for the advantage of comparison with his excellent timepieces.

I would also avail myself of this occasion, to express my personal obligations to those Gentlemen, for the opportunity which I have enjoyed of conducting these experiments ; and for which I am sensible that I am chiefly indebted to the statement they were pleased to make, of my competency to fulfil the purposes which the Society had in view.